A First Mile Initiative

promoting the adoption of broadband-friendly practice and policies

Authored by representatives for Technology Transfer Alliance member institutions:
Björn Pehrson and colleagues and students at KTH Royal Institute of Technology, Amos Nungu, DIT, Abdisalaam Mohamed, SHERnet, Boubakar Barry, AAU, Donart Ngarambe, Kigali Regional eHealth Centre, Etienne Ntagwirumugara, Rwednet, Felix Akorli, National University of Rwanda, Idris Rai, Makerere University, Lars L Gustafsson, Karolinska Institutet, Marco Zennaro, ICTP, Omo Oaiya, Eko-Konnect, Patrick Mangheni, RENU, Victor Kyalo, Kenya ICT Board, Simon J E Taylor, Brunel University.

Abstract

We argue that the impact of the emerging African broadband infrastructure on the progress towards the Millennium Development Goals can be enhanced considerably by complementing the ongoing backbone and last mile efforts with a first mile initiative, systematically involving local community networking groups, supported by research and higher education institutions. We discuss the models for doing this and present conclusions and recommendations.

Introduction

Since a decade, the African Communication Infrastructure is being transformed from being satellite based to becoming terrestrial optical fibre based. This is expected to expand the market in magnitude and transform it from being low-volume/high-price to becoming high-volume/ low-price, which is similar to what has already happened, or is happening, in other regions. Due to the impact of Broadband ICT on all sectors of society, the process offers quick advances to Millennium Development Goals [1,2,3,4].

There are important ongoing efforts driven by policy-makers, regulators, telecommunication companies and other actors on the producer side of the supply chain. All of them are supported by donors and financial institutions, in order to deploy more submarine cables, national back-bone networks, access networks and last mile links [5].

However, on the consumer side, there are few users involved. In this paper we suggest that the process can be made more efficient (while waiting for last mile connections) by systematically involving consumers in a complementing first mile initiative supported by research and higher education institutions, which are capable of developing the ICT capacities. We discuss the models for doing this and present conclusions and recommendations. The progress towards the Millennium Development Goals can be more efficient if the consumers would drive demand side efforts.

Description of the problem

There is a lack of awareness among key actors in the process to roll out broadband. On the side of the policy-makers, regulators and producers, this is reflected on their limited knowledge of local needs, demands and requirements. And on the consumer side, it is shown by their inability to see potential benefits, express their needs and requirements, and take advantage of a new infrastructure that in most cases has not yet materialized. Part of the problem is the fact that there are too few organized user communities on the consumer side.

A UNBC First Mile Initiative?

A first mile initiative would complement the producer commercial last mile efforts with consumer-driven first mile efforts with a special focus on local communities in remote rural areas where there is demand for broadband services but no supply. Priority should be given to services supporting progress towards the Millennium Development Goals according to main stream implementation plans of national development strategies, especially healthcare, education, local administration and support to local entrepreneurs.

The initiative should stimulate the formation of local community networking task force groups involving the local municipality and entrepreneurs. The mission of these task force groups would be to create awareness among consumers and to communicate needs, requirements and demand by establishing local broadband islands [9,13]

Local Area Networks versus Internet access

Local communication needs are often neglected and shadowed by the dream of Internet access. A usual argument against local services is lack of local content.

We argue that, where there is people, there is always local content, to mention a few:

- Sentinel surveillance and consultations between primary health centres and district hospitals via voice and video
- Reliable information related to health and medical drugs, secure distribution and monitoring of the use of drugs
- Administrative tasks involving the district council offices, schools, healthcare units
- Monitoring and control of animal disease and sharing of information on best practices in farming to improve yield and reduce loss.
- Local environment data, such as water quality, insolation, wind and other weather parameters, etc.
- With some delay, it is also possible to establish local repositories of educational data imported physically and stored on local servers

We also argue that focusing on local needs is an efficient

way to raise awareness of the benefits of broadband services. Local Broadband Islands are important even with no or only narrowband upstream connections to Internet! Rather than passive waiting for the last mile to arrive, proactive local community networking task force groups can accelerate the development.

Methodology

The methodology we propose as the basis for the activities of the Community Networking Task Force group is iterative pre-commercial procurement. The first step is a baseline study with mapping of needs, demand and requirements, and identification of locally available competence in the supply chain. The results are documented and put forward as a procurement based on open calls for tenders. If there is no tenderer, which is often due to perceived risk levels, the reasons are analysed and a social business based effort [7] is made by the community to mitigate the most prominent risks. Any assets resulting from such efforts, such as local fibre cables, ICT equipment, spaces, can be included in offers for public private partnerships in the next iteration of the procurement process. The iteration continues until commercial tenderers step forward with reasonable offerings. This strategy has been tested both in developed and developing regions and been successful in the sense that commercial markets have eventually emerged [9, 13].

Development muscle

The Community Networking Task Force groups can benefit from teaming up with local research and higher education institutions as development partners. Such institutions are in many contexts forceful agents for change and have been key actors in the Internet revolution all over the world. They constitute one of the largest and most homogeneous consumer groups on the communications market and are often serving as anchor customers in more populated areas in the same way as the Community Networking Task Force groups can serve as anchor customers in the rural areas. The local research and higher education institutions can in their turn rely on a global support from their peers, e.g. in the Technology Transfer Alliance.

Technology Transfer Alliance (TTA)

The Technology Transfer Alliance (TTA) is an association of higher education institutions offering students and staff opportunities to integrate important development projects in their academic curricula via problem-based, project-driven learning for academic credit according to proven pedagogical models.

The purpose of TTA is to support capacity building of human resources as well as development of adequate and innovative technical solutions, focusing on ICT and Renewable Energy.

Besides the problem-oriented, project-driven model of advanced and controlled learning-by-doing, the pedagogical model includes peer-learning in teams and vicarious learning from earlier teams.

Such earlier deliverables, available for the teams, include open source software and lists of selected hardware for high performance, low-effect routers, video-conferencing systems, network and service management systems, etc. They also include designs using alternative power sources and power storage technologies, methods for selecting hardware, performance evaluation, etc.

Examples of methods to systematically involve key stakeholders in multi-stakeholder partnerships include the formation of “Living Labs” including user participation and Pre-Commercial Procurements.

TTA facilitates brokering of projects involving research and education activities in multi-stakeholder private-public partnerships with goals of relevance to society and to industrialisation of research results. TTA demonstrates south-south and south-north cross-border cooperation in terms of cooperation on curriculum development, establishment of research infrastructures and pooling of resources,. The TTA projects also offer students career opportunities and introduction to working life.

Examples of past and current activities according to the TTA model are discussed below.

Serengeti Broadband network

This network is designed and deployed by students in the framework of the Tanzania ICT for Rural Development programme organised according to the Technology Transfer model with the purpose to design and validate a scalable strategy for how to establish sustainable broadband markets in areas where there is demand but no supply. The effort started in 2005 with Sida support [9] .

The approach has been to facilitate public investments in infrastructure by focusing on basic public services, such as education, healthcare, local government and support to rural entrepreneurs. To design business models for sustainable operation of the infrastructure and services, every stone is turned to find users that can benefit from the services and are able to pay for them.

The Serengeti Broadband network is based on Gigabit Ethernet links over optical fibre deployed in the grounding wire on top of the power line between the Bunda and Serengeti districts in northern Tanzania. The picture is from the Nata Village where a secondary school and the primary health centre are connected.

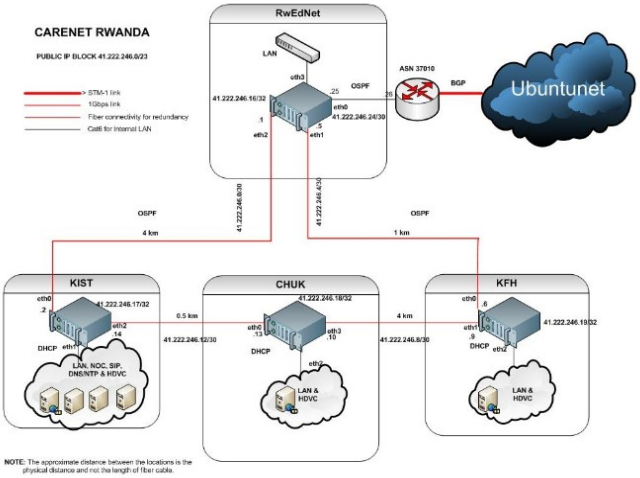
Public private partnerships have been formed in both districts involving both central and local government, community based organisations, NGOs and private companies. The possibility to extend the Serengeti Broadband Network into the rural areas around all the African Great Lakes is being discussed.

RWEDNET

The first phase of the Rwanda National Research and Education Network, RWEDNET, was deployed according to the Technology Transfer Alliance model [10]. The Government of Rwanda decided early to offer all research and higher education institutions access to dark fibre. The fibre connecting the first institutions via the metropolitan area fibre network in the capital, Kigali, has been provided by Rwanda Development Board.

The fibre is used to implement an IP-network over a Gigabit Ethernet ring network connecting Kigali Institute of Science and Technology (KIST) and the two university hospitals (CHUK and KFH) to the point of presence of the regional backbones connecting to the intercontinental submarine cables and to the national Internet exchange point, RINEX. Here, RWEDNET can get both local peering and upstream transit connectivity, both to Internet and eventually to all the global dedicated research and education networks via Ubuntunet and Géant,

A high definition video conferencing service has been deployed in the network with clients at the two university hospitals and at KIST. The service is used for international cooperation on research and education, initially in Healthcare, ICT and Renewable Energy. The activities in the healthcare sector has so far been conducted in the context of the Carenet project, which was presented and demonstrated at the ERINA4Africa workshop in Lilongwe in October 2010. The demonstration included a pioneering HDVC session between surgeons in Kigali, Lilongwe and Stockholm discussing regional differences in treatment practices of portal hypertension.



The picture illustrates the ring topology of the network connecting Kigali Institute of Science and Technology and the two university hospitals, CHUK and KFH, to the Internet exchange point.

The network, services and management tools are designed and deployed by students and staff using open source software and selected off-the shelf hardware components.

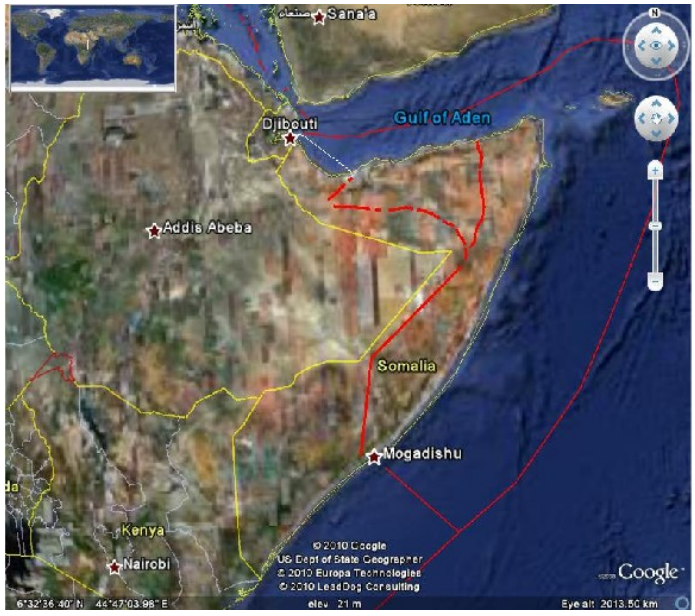
Eko-Konnect

Eko-Konnect is a university network set up in the Lagos Higher Education Connectivity Project [11] . Five campuses are connected with each other and the Internet Exchange Point in Lagos where the universities can get both transit and peering with local commercial networks

The Eko-Konnect network is based on wifi-links connecting the five campuses and the Internet exchange point in a ring.

Somali Universities as Agents For Change

This is an initiative from the nine university presidents of the SomaliREN member institutions, all of them also associated with the Technology Transfer Alliance, and supported by the Somali diaspora. The universities are one of the few organisations cooperating on a national level. Within this initiative, there is also the Fibre for Peace initiative [12] pushing for a national fibre infrastructure. Diaspora-supported efforts are under way to establish SomaliREN links between the universities.



TTA Systems and components

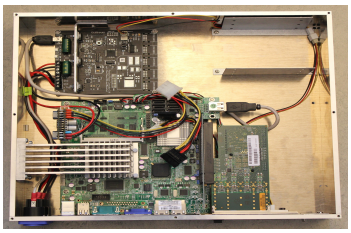
A number of technical products have been developed, tested and documented in earlier TTA projects, including those discussed below. They are all based on open source software and carefully selected off-the-shelf hardware components. The hardware lists are publicly available and the designs are free to copy and use for any purpose.

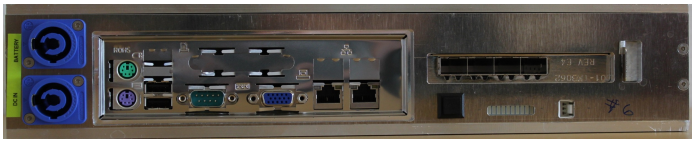
Cooperation with systems integrators and distributors offers the choice to buy components and build in-house or to buy already assembled products from a distributor.

Solar-driven Linux Router

This high-performance Linux router, designed by students and staff at TTA member universities, routes 700 kpps at 20W. It can be powered by solar or wind and has an

integrated power management module controlling charging of a battery.





This version of the router has six 1 Gigabit Ethernet ports. Optical ports support digital optical monitoring. It has no moving parts, such as fan or disk.

High-definition video conferencing client

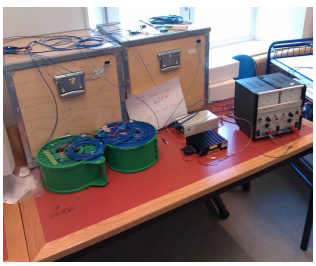
High definition video conferencing (HDVC) facilitates powerful telemedicine and elearning applications.

In a similar way as with the router above, a series of students projects have resulted in a high performance HDVC client based on open source software and carefully selected off-the-shelf hardware components.

TTA designed Open Source High Definition Video conferencing Client used in the pioneering session between experts in Kigali, Lilongwe and Stockholm organised by the ERINA4Africa project [6].

Solar-driven Optical Amplifier

A solar-driven Erbium-Doped optical Fibre Amplifier (EDFA) consuming less than 5W has been developed and tested in the laboratory to establish a 1 Gigabit Ethernet link over 330 km. Field tests are under way.



The picture to the left illustrates test of the solar power control system and the picture to the right shows the testing of the optical amplifier over 334 km fibre stored in the boxes and rolls on the table.

Alternative Power Storage

The commonly used lead-acid battery has limitations regarding deployment in heavy-duty, high-temperature environments. An alternative battery technology based on ultra-capacitor cells has been tested in the laboratory with positive results and field tests are under way.

This battery contains sixteen 3000F capacitors as cells.

Future plans

The potential of the Technology Transfer Alliance to contribute to the First Mile Initiative by supporting Community Network Task Force groups is growing as new members join. Current and planned efforts include: Support to more community networking Task Force groups as well as development of adequate network components, networks, services and applications.

Examples of areas already in the starting blocks are discussed below.

Green Networks

On the network component level, the plans include development of green network components powered by renewable energy sources and alternative storage technologies.

Delay Tolerant Networks

In areas where it is not possible to establish any other links, for one reason or another, physical transportation of data is an alternative. Development efforts are already in progress taking advantage of the increasing availability as smartphones equipped with substantial memory sizes and connecting both to WiFi and mobile networks. By use of the bundle protocol and probabilistic routing, these phones can serve as data links when carried around.

Community-based Wireless Sensor Networks

Sensor networks are facilitating a revolution in our understanding of nature by providing observations at a fine spatial-temporal resolution. They have the potential to revolutionize science and influence social, environmental and health issues. Local networks will foster the growth of participatory sensing systems. A participatory sensing system is one that starts and ends with people both as individuals and members of communities to allow individuals and communities to collect, share and organize information, with the objective of making a case for change and exploring and understanding their life and relationship with the environment

Grid and cloud computing

The current set of software distributions will be extended with grid and cloud computing tools to support infrastructure sharing.

There are many applications that need Grid Computing to speed up their execution. An example is Auto-Dock to investigate molecular docking in the Natural Products Research Network in Eastern and Central Africa (NAPRECA). A 'conventional' approach to this problem is to use computing clusters linked via Grid Computing middleware such as gLite to speed up the application (http://applications.eu-eela.eu/application_details.php?l=20&ID=55).

However, in regions where there is still low bandwidth or a lack of appropriate ICT skills, an alternative approach exists. Desktop Grid Computing aims to use local desktop PC resources in a Computational Grid (running Linux or Windows).

The European Desktop Grid Initiative (www.edgi-project.eu) has developed simple, easy to maintain Grid Computing software (SZDG) that can be used to implement a local Grid. The SZDG is augmented with the gUse workflow portal to make job submission to a local grid straightforward. Importantly, this Grid Computing technology has an upwards scalability path to European Grid Initiative (EGI) type Grids. This approach is attractive as it allows potential Grid users to get up and running quickly and locally, as well as being able to link to worldwide Grids as bandwidth becomes available.

Conclusions

We conclude that it is possible to boost ongoing last mile efforts with establishment of first mile broadband islands as social businesses demonstrating feasibility, needs, requirements and demand and reducing all sorts of risks. Such an initiative will accelerate development and local administration reform, create jobs and business opportunities and inverse urban-rural migration.

Establishment of local broadband islands and stepwise access to the outside world will help developing distance consultancy services in the healthcare and education sectors. This can rapidly increase the access to learning tools and guidelines for appropriate and safe health care by establishing community health portals. Information from these can be accessed through broadband island networks.

Key policy issues

It is sometimes debated if the provision of communication infrastructure and networks should be left entirely to the market forces and that services will be provided if there is only a demand. This might be true in densely populated areas in developed regions but is definitely not true in sparsely populated areas, especially if infrastructure investments are necessary. In such areas, it is evident that communication infrastructure should be regarded as a utility, like roads, neutrally managed and allowing access should be open to anyone at reasonably cost-related rates, whether the purpose is to build a network offering services on a commercial basis, or a dedicated network for a closed user group.

Other important issues to solve in Africa is transborder communication between neighbours and to stimulate the use of innovative technologies, including both ICT and Renewable Energy.

The public good, strictly non-commercial, research and education networks of research and higher education institutions can be used by policy-makers, regulators as well as by the operators and service providers to experiment and showcase without disturbing the commercial competition balance

Recommendations

Our recommendations include:

- Stimulate the implementers of National ICT Strategies, on the grass root level, to midwife Community Network Task Force groups.

- Encourage the local universities to integrate research, development projects and learning into their academic curricula taking advantage of open resources available via the Technology Transfer Alliance, to support the Community Network Task Force groups.

- Use the public good, strictly non-commercial, research and education networks as spearheads to demonstrate innovation in policy and regulation, services, technical solutions and business models without commercial commitments and disturbances in the commercial competitive environment.

References

[1] UN Millennium Development Goals, www.un.org/millenniumgoals/

[2] Open Access for Africa, published by UN ICT Task Force, 2005

[3] UN Broadband Commission, www.broadbandcommission.org

[4] UN Broadband Commission Working Group for Broadband and Science concept notes

[5] Feasibility Study for AfricaConnect, www.feast-project.org

[6] ERINA4Africa www.erina4africa.eu

[7] Muhammad Yunus, Social Business, www.muhammadyunus.org/SocialBusiness/social-business/

[8] Technology Transfer Alliance, http://tta.ssvl.kth.se

[9] Tanzania ICT for Rural Development, www.ict4rd.ne.tz

[10] Rwanda Carenet/Rwednet project www.rwednet.ac.rw

[11] Lagos Higher Education Connectivity Projects, www.eko-konnect.org.ng

[12] Fibre for Peace, contact@somalifibreoptic.org

[13] KTH Research on ICT for Rural Development, www.tslab.ssvl.kth.se/publications